Science Contest

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ASTRO-E2 SCIENCE COMPETITION

OBSERVE THE UNIVERSE WITH NASA SCIENTISTS!

Reach for the stars and work with professional astronomers!

If you are a high school teacher or a student interested in science and how science is done, this contest is for you.

If you are passionate about astronomy and want to learn first-hand what professional astronomers really do, this contest is for you.

If you want to get a first glimpse at black holes or clusters of galaxies (or any other subject of your choice) using the newest NASA X-ray observatory, this contest is for you.

We are offering a new and innovative program that will open the doors of research to a team of highly motivated high-school students. From December 1, 2004 to April 30, 2005, we will accept and review proposals from high-school teams for the Astro-E2 satellite. The proposal should suggest a unique object that Astro-E2 should study. We will select a proposal and the students will work alongside with scientists to study their proposed object.

The proposal will be carried out by Astro-E2, the most recent of the X-ray observatories to be launched by the Japanese Space Agency (ISAS) in collaboration with NASA. Astro-E2 will be launched in February 2005.

Astro-E2 is designed to complement the Chandra and XMM-Newton missions which have both made important discoveries.

There are three main instruments on board Astro-E2. Each has a particular role in studying X-rays. The main instrument, a micro-calorimeter (a small device is able to detect very small changes in temperatures) called the XRS, is the first (and the best!) micro-calorimeter ever flown in space and promises to yield stunning discoveries. The XRS can distinguish very small differences in the energy of the X-ray photons. For example, the XRS can study the matter near a black hole.

Each proposal entry should describe a research project that includes an observation with the XRS of an astronomical object.

The winning team will analyze the data with the help of professional astronomers and will travel to the summer or winter meeting of the American Astronomical Society to present the results of their analysis.

This is a once in a lifetime opportunity that any scientist would love to have! To learn more about what the satellite is best suited to study and how the proposal process works, read the rest of the science contest pages and the entire Astro-E2 website.

The following pages describe the contest and how to enter. Teachers, please refer also to the end of the site for teaching goals.

Possible science projects with Astro-E2:

To give students and teachers a head start here is a brief summary of what the Astro-E2 will be able to study and possible projects.

Some of the key themes that Astro-E2 will be able to advance are:

* Where and when are the chemical elements created? Astro-E2 can probe the amount of oxygen, silicon, iron and other elements in nearby stars, supernova remnants in our Galaxy and its neighbors, and in distant clusters of galaxies.

* What happens when matter falls onto a black hole? Astro-E2 can measure the velocities of matter around a black hole in a binary star system, or at the center of a galaxy.

* How does nature heat gas to X-ray emitting temperatures? The sensitive measurements of Astro-E2 may help scientists explain how gases are heated to X-ray temperatures in the corona of a star, or how (how much) cosmic ray particles are accelerated in young supernova remnants.

Below are some examples of projects you could undertake. There are many more!!

Newborn Stars

Astronomers have been intently studying the development of newborn stars: how they are formed, what they form into, how sometimes stars split off into two stars. By studying newborn stars, scientists can even learn more about how planets are born.

Supernova remnants

Supernova remnants (SNRs) can be perfect targets for a mission looking at line-rich spectra. These lines can come from elements created and ejected in the supernova explosion. By looking at what elements are detected in the Astro-E2 spectrum, astronomers can determine what type of star was at the origin of the SNR (a massive star or a white dwarf).

Clusters of Galaxies

Clusters of galaxies are the largest systems in the universe. Astro-E2 can investigate how they formed and test the different theories of their evolution. The lines detected by Astro-E2 from sources emitting from clusters of galaxies will help form theories about the clusters and those dynamics.

The Galactic Center

There is existing evidence of a hot gas and strong line emission of elements like Silicon, Sulfur, Argon, Calcium, and Iron from the Galactic Center. The existing measurements are not fully understood and Astro-E2's look at the Galactic Center may help explain the state of ionization of these elements.

Active Galactic Nuclei (AGN)

Astronomers think that there are super-massive black holes at the center of each AGN. This is because of previous measurements showing that the characteristic shape of Iron's line emission is distorted in a way one would expect from an accretion disk around a black hole. The shape of the line depends on a number of parameters, including the spin of the accretion disk around the black hole, so Astro-E2 offers the first direct method to identify and quantify a black hole.

The Birth of the Universe

Astronomers think that by studying X-rays they can learn more about the true birth of the universe. When the first missions studied the sky at X-ray frequency, astronomers noticed what was a uniform "glow" that could not be explained. This X-ray "background" has been a standing mystery until recently. Chandra X-ray observatory showed that the X-ray background was made by hundred of small sources that were too tiny to be separated by other satellites.

How to enter the competition

1. Read about the Astro-E2 web site.

When you enter this competition, you will write a proposal to use the Astro-E2 satellite. It's pretty hard to use something if you don't know what it does first. Take the time to read up on Astro-E2 before you start writing.

2. Form a team with your classmates to write the proposal and analyze data if you win.

If you win this competition, you will have access to scientific information like that professional astronomers work with every day. Analyzing this information (or even entering this contest) is a lot easier to do if you have a team of people to work with. So, be sure to choose team members who like science, can write well, and are ready to learn a lot to prepare for this proposal.

3. Decide on a general topic to study.

Start your first team meeting by deciding what you want to study. Do you want to learn how stars emit X-rays? How about what is in a supernova remnant? Or what happens near a black hole? You can choose from many topics like galaxies, new-born stars, or the birth of the universe. If you get stuck trying to find an idea or don't know what things you can observe, talk to a science teacher. If you haven't done so already, read through the Astro-E2 web site for ideas.

4. Contact us.

After you have decided on a topic to study, write to Ilana Harrus at competition@athena.gsfc.nasa.gov. Send Ilana a letter saying what you want to study and why it interests you. She will help you choose an object that matches your interests. .

5. Research your object.

Look up as much information about your object and its type of objects as you can. Look in science magazines, books, and on the Internet. Don't forget to ask your teacher as well. Write a summary about everything you learned. This summary will help you organize your information and let you see what more can be learned about the object. Write down any questions you have while writing the summary. Think about the information missing from your summary and your questions. Consider how the Astro-E2's instruments (especially the XRS) can provide answers to those questions.

Talk to your teacher about this missing data or write Ilana. We can give you hints and answer questions or tell you if one of your questions would be a good topic for your proposal.

6. Write the proposal.

Once you have done the background research and focused on the questions you want to answer, write an explanation for why you think Astro-E2 can help answer your questions. Try to make your explanation as specific as possible but don't worry if you can't justify everything. Just be sure to include what the XRS will contribute to your proposal. The XRS is a unique instrument and we won't consider proposals that don't use it.

What happens if you win?

Restrictions on the winner's data

The winning team will be given access to data that are off-limits to most of the astronomical community. The team will be allowed to look and work with data that are still proprietary. The winning team will have to sign agreements not to publish anything without the explicit accord of the GSFC team and not to let people (other than the ones signing the agreements) to look at the data.

Once you've signed the agreement, astronomers and other scientists will help you analyze the data from your observation and you will have a chance to present your work during a conference of the American Astronomical society.

Proposal format

The actual entry that students send in will consist of:

1) A cover page with the list of participants, their names, address and their contributions to the proposal. To help you with this, we have created a template of a cover page that you can use. You can also create your own,

2) The letter of agreement signed by all the participants to the proposal.

3) The text of the proposal. This should be no more than four pages long and a minimum of 2 pages (with a minimum of 11 pt font for the text please.) It should be clear and well organized (see below.)

4) A list of the references that you used during the preparation of your proposal.

How to write a proposal

A proposal is an argument you make to convince someone to let you do something. Scientists write proposals to convince the government or other agencies that fund research to give them money to do their research. In addition to writing proposals for money, astronomers write proposals to convince the owners of telescopes to let them observe objects in space. Astronomers build their argument with information about what they want to observe and why it is important to do so.

When astronomers write proposals, they include answers to the following questions. Your proposal should also contain this information.

1. What is currently known about the type of your object?

When preparing for the competition, you are asked to choose a type of object, e.g. a black hole, and then research that type. Begin your proposal with a summary of what you found. It doesn't have to be long but make sure your summary is thorough.

2. What isn't known about the type of your object?

Scientists don't know everything. While you researched your type of object, you probably came up with questions that scientists have not yet answered. Talk about those questions. Discuss what science doesn't know and how filling in those gaps would help get a clearer picture of your object's type. Justifying your questions may seem difficult, but remember you don't have to make a big discovery with your observations.

3. What do you want to study?

This is a question we will partly answer for you: once you decide the sort of objects you want to study, we will give you a list of objects that you can chose from. Tell us why you chose one object rather than another on the list.

4. What is your hypothesis?

State your hypothesis, i.e. the answer you think you will find after the observation. Include what you hope to see in the data that would prove your hypothesis.

5. Why use Astro-E2?

Tell us why you want to use the Astro-E2 satellite to make your observations. Talk about the information that each satellite's instruments can gather and how that information can help answer your questions. You don't have to discuss or use all the instruments on the Astro-E2, but you do need to use and discuss the XRS.

6. What are your references?

List all of the books and articles you read when you were researching your object and writing your proposal. Be sure to include sources for all of the information you had to look up. You can use any reference format you want.

Grading sheets

Points	1. Research subject What subject are you going to study? Why are they interesting to you? Why do you need ASTRO-E2 for this project?	2.Background research What is known so far on these objects? What are the questions your observation would answer?	3.Research plan How will the data help answer the questions asked? Can you assess the importance of your result?
0	There is no research subject stated.	There is no mention of either background research or the questions that this study would address.	No explanation of what will be done with the data or about the scientific importance of the results.
1	The research subject is not clearly stated.	The background research is not properly referenced. The questions posed are unclear.	The link between observation and hypothesis is poorly explained. The importance of the results is unclear.
2	The research subject is given, but the justification for it is poor.	The background research is given but not well explained.	The importance of the results misses most of the real science behind the observation.
3	The research subject is well described. The justification is clear.	The background research is well documented and explained.	The importance of the science behind the observation is well explained.
4	Justification and research subject are exceptionally clear.	Background research is worthy of a review article. It includes references to professional journals and covers the subject completely.	Importance of the science is clearly explained and is recognized in the scientific community.
	Points x 15 = Subtotal =	Points x 5 = Subtotal =	Points x 15 = Subtotal =

Points	1. Team composition Do team members have relevant skills to carry out the project?	2. Team support Has the team enlisted the support and cooperation of the school and community?	3. Presentation Is the proposal clear and well written? Are all spelling mistakes corrected? Are all rules for pages, and fonts respected?	4. Overall work Are there enough references and clear marks of a thorough treatment of the subject?
0	No information on the team is provided	No information is provided.	The proposal is filled with spelling errors and typos. The proposal is under/over the page limit.	There are none.
1	The team appears ill prepared. No clear roles are assigned.	The team has considered some support but has only vague plans to do so.	The proposal lacks clear organization and layout.	There are a few. The references are all linked to one unique source.
2	The team appears well composed but there are no clear assignments for the different tasks.	The team has a clear plan to recruit the support they require.	The proposal is clearly written. The presentation is well done and engaging.	There are a few but the references show some work in researching the subject.
3	The team appears well composed and its members have clear work assignments in the project.	The team has already gathered support from qualified individuals.	The proposal is very well written and well organized. Pictures, graphs, or tables are used wisely.	There are a lot of references. The students have researched the subject completely.
4	The team consists of people with some expertise as proven by past experience (science fair, prize, fellowships, awards).	The team has already benefited from the support from qualified individuals.	The proposal is exceptionally well written. It is both educative and informative.	The references are not only numerous, but their extent denotes a clear understanding of the current research subjects. This is a professional quality work.
	Points x 10 = Subtotal =	Points x 5 = Subtotal =	Points x 5 = Subtotal =	Points x 10 = Subtotal =

Resources

Here are a few web sites you can look at for more information about Astro-E2's instruments:

"The Astro-E2 Mission" from NASA's High Energy Astrophysics Science Archive Research Center

http://heasarc.gsfc.nasa.gov/docs/astroe/astroegof.html

HXD: Hard X-ray Detector from the University of Tokyo

http://www-utheal.phys.s.u-tokyo.ac.jp/hxd/index.html

University of Kyoto's X-ray Imaging Spectrometer home page

http://wwwxray.ess.sci.osaka-u.ac.jp/xis/xis.html

Astro-E's X-ray Imaging Spectrometer from MIT Center for Space Research

http://acis.mit.edu/acis/syseng/astroe/xis_home.html

The Astro-E2 page at Japan's Institute of Space and Astronautical Science

http://www.astro.isas.ac.jp/astroe/index-e.html

Astro-E2's X-ray Telescopes at the Laboratory for High Energy Astrophysics in NASA's Goddard Space Flight Center

http://lheawww.gsfc.nasa.gov/docs/xray/astroe/MirrorLab/xrt.html

Teachers:

Congratulations for being interested in getting your students involved in the Astro-E2 proposal competition!

Why should your students participate in this competition?

The advantages of participating in this competition are multiple: learning about cutting-edge research problems in astronomy and astrophysics, working with professional astronomers, understanding the challenges of any research project, and polishing writing skills.

This is a highly competitive competition aimed at the students who are capable and eager to working hard and quickly understanding difficult concepts. Your students will benefit from the exposure to professional astronomers at every stage of the process.

They will first write a letter of intent to the team at the NASA Goddard Space Flight Center (GSFC). The team will help guide the students in what to study with the satellite. The astronomers will be there to help them understand the challenges and the difficulties of writing a proposal but not to help them write it. Students will also use the resources on the web to write the proposal.

In the process of this competition, they will learn about astronomical objects that they will select for their proposal. They will have to investigate the science and the reasons these objects intrigue scientists. They will explore the mysteries that are to be solved and learn by regular contact with the scientists at GSFC.

One more skill that students will acquire will be a familiarity with computers and web browsers. They will learn how to use simple analysis software for X-ray astronomy.

Standards:

This competition is an exceptional opportunity for your students. It involves many science teaching and content standards. We have also outlined many teaching and classroom standards that their involvement in the competition can accomplish. In addition, English composition standards are also addressed.

To learn more about the standards and advantages please read on.

Teaching Standards(Grades 9-12):

STANDARD A:

Teachers of science plan an inquiry-based science program for their students. In doing this, teachers

* Develop a framework of yearlong and short-term goals for students.
* Work together as colleagues within and across disciplines and grade levels.

STANDARD B:

Teachers of science guide and facilitate learning. In doing this, teachers

* Focus and support inquiries while interacting with students.
* Orchestrate discourse among students about scientific ideas.

* Challenge students to accept and share responsibility for their own learning.
* Recognize and respond to student diversity and encourage all students to participate fully in science learning.
* Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.

STANDARD D:

Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science. In doing this, teachers

* Structure the time available so that students are able to engage in extended investigations.
* Create a setting for student work that is flexible and supportive of science inquiry.
* Make the available science tools, materials, media, and technological resources accessible to students.
* Identify and use resources outside the school.

STANDARD E:

Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning. In doing this, teachers

* Enable students to have a significant voice in decisions about the content and context of their work and require students to take responsibility for the learning of all members of the community.
* Nurture collaboration among students. Structure and facilitate ongoing formal and informal discussion based on a shared understanding of rules of scientific discourse.

Classroom Standards:

For the Astro-E2 competition, students should be encouraged to work with their peers and teachers in the process of research and scientific inquiry. Though the competition is team-oriented teachers should encourage students to perform scientific inquiry as individuals and should be treated as individuals. Below is a table outlining these guidelines.

LESS EMPHASIS ON	MORE EMPHASIS ON
Treating all students alike and responding to the group as a whole.	Understanding and responding to individual students' interests, strengths, experience and needs.
Rigidly following curriculum.	Selecting and adapting curriculum.
Focusing on student acquisition of information.	Focusing on student understanding and use of scientific knowledge, ideas, and inquiry processes.
Presenting scientific knowledge through lecture, text, and demonstration.	Guiding students in active and extended scientific inquiry.
Asking for recitation of acquired knowledge.	Providing opportunities for scientific discussion and debate among students.
Testing students for factual information at the end of the unit or chapter.	Continuously assessing student understanding.

Maintaining responsibility and authority.	Sharing responsibility for learning with students.
Supporting competition.	Supporting a classroom community with cooperation, shared responsibility, and respect (except of course they're competing with other teams).
Working alone.	Working with other teachers to enhance the science program.

Science Content Standards for Students (grades 9-12):

Though the actual proposal has much emphasis on scientific inquiry the process of learning about the satellite and its instruments involves many science content standards. Learning about elements to study also heavily involves many science content standards. The following standards encompass all of the standards in the student process. *The standards in italics are specific for the proposal.*

Science as Inquiry

CONTENT STANDARD A: As a result of activities in grades 9-12, all students should develop

* *Abilities necessary to do scientific inquiry*
* *Understandings about scientific inquiry*

Physical Science

CONTENT STANDARD B: As a result of their activities in grades 9-12, all students should develop an understanding of

* Structure of atoms
* Structure and properties of matter
* Motions and forces
* Conservation of energy and increase in disorder
* Interactions of energy and matter

Earth and Space Science

CONTENT STANDARD D: As a result of their activities in grades 9-12, all students should develop an understanding of

* Origin and evolution of the universe

Science and Technology

CONTENT STANDARD E: As a result of activities in grades 9-12, all students should develop

- *Abilities of technological design*
- *Understandings about science and technology*

Science in Personal and Social Perspectives

CONTENT STANDARD F: As a result of activities in grades 9-12, all students should develop understanding of

* *Science and technology in local, national, and global challenges*

History and Nature of Science

CONTENT STANDARD G: As a result of activities in grades 9-12, all students should develop understanding of

- *Science as a human endeavor*
- *Nature of scientific knowledge*
- *Historical perspectives*